Rehabilitation of the Wellington Caves Phosphate Mine: Implications for Cainozoic Stratigraphy

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Rehabilitation work on the Wellington Caves Phosphate Mine has revealed stratigraphic sections and boundaries which were not exposed when Frank (1971) and Osborne (1983) undertook their studies. As a consequence the Cainozoic stratigraphy at Wellington Caves is now seen to be in need of revision.

Preliminary investigations have revealed the presence of a previously unrecognised stratum of Pleistocene clay, up to 4 m of undifferentiated strata of probable Pliocene age and the presence of a second major unconformity within the sequence.

The newly-recognised unconformity separates strata of known Pliocene age from an older sequence whose fauna has yet to be studied. Given that the unconformity is likely to represent a significant time break, the older sequence is likely to be significantly older than Pliocene.

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INTRODUCTION

The Wellington Caves Phosphate Mine (Fig. 1) operated between 1914 and 1918 during which time some 6,000 tonnes of phosphate rock were extracted from workings in sediment-filled limestone cave passages at Wellington Caves in central western New South Wales. The mine intersected significant deposits of bone-bearing strata, particularly red cave earth, which have formed the basis for most 20th century palaeontological studies at Wellington Caves.

Fossils from the Phosphate Mine and from Bone Cave, which has now been shown to be an abandoned early section of the mine, have been extracted and studied by Anderson (Anderson 1926) and Brown (Brown 1926) in the 1920s, Anderson and Schevill (Anderson 1933) and Schroeder and Dehm in the 1930s (Augee et al. 1986), Marcus (Marcus 1962), Mahoney and Lundelius (Lundelius 1966) in the 1950s, Hope in the 1960s and Augee and Dawson in the 1980s and 1990s.

The exposures in the mine have been the most instructive of all in elucidation of the Cainozoic stratigraphy at Wellington Caves and formed the basis for unpublished work by J. Mahoney in the 1950s and the major stratigraphic studies of Frank (1971) and Osborne (1983).

THE PHOSPHATE MINE RESTORATION PROJECT

The condition of the Wellington Caves Phosphate Mine deteriorated significantly during the 1980s and 1990s and it became clear by 1994 that some sections of the mine

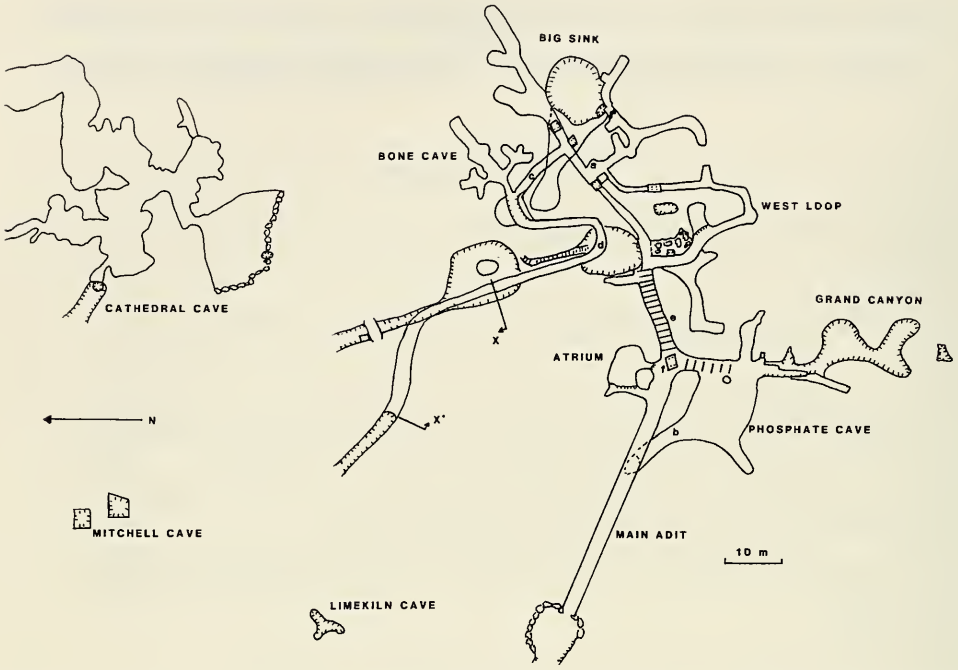

Figure 1. The Wellington Caves Phosphate Mine. (a) 'Shaft Cave' fossil locality of Schroeder and Dehm, (b) 'Phosphate Cave' fossil locality of Schroeder and Dehm, (c) Adit connecting Bone Cave to the mine, reopened during rehabilitation in 1995, (d) Cut and fill passage joining Bone Cave to minor adit, formed in early 1996, (e) Timber platform used to mine phosphate, (f) North Shaft, (X-X') New adit through massive limestone constructed in 1995 to provide second tourist entrance to mine.

were in imminent danger of collapse, in particular the passage that provided access to Schroeder and Dehm's 'Shaft Cave' fossil locality.

During the early 1990s some members of the Wellington Caves Advisory Committee, which assists Wellington Council in management of Wellington Caves, in particular Campbell Gregory, came to believe quite strongly that the Phosphate Mine had considerable potential for development as an additional tourist attraction at the caves. As a result Wellington Council was strongly lobbied to take action to prevent further deterioration of the mine and to begin a process that could eventually result in the mine being rehabilitated and developed as a tourist attraction.

In mid 1994 Wellington Council commissioned a series of studies to assess the feasibility of rehabilitating and developing the mine. These examined: the bat population (Dovey 1994), geological and palaeontological features (Osborne 1994) and mining heritage and archaeology (Godden Mackay 1995). A mining survey and estimate of rehabilitation costs were undertaken (Donnelly Mining and Civil Pty Ltd. 1994) and in July 1994 the most unstable section of the mine was given temporary support using expandable metal props.

In July 1995 Wellington Council received funding under the New Work Opportunities Scheme through the Department of Employment Education and Training to employ up to thirty people for six months on the Phosphate Mine project. From July 1995 to April 1996 Wellington Council provided funding to cover supervision, capital materials, an interpretation study (Hamilton-Smith and Osborne 1995) and all other necessary works to bring the project to completion.

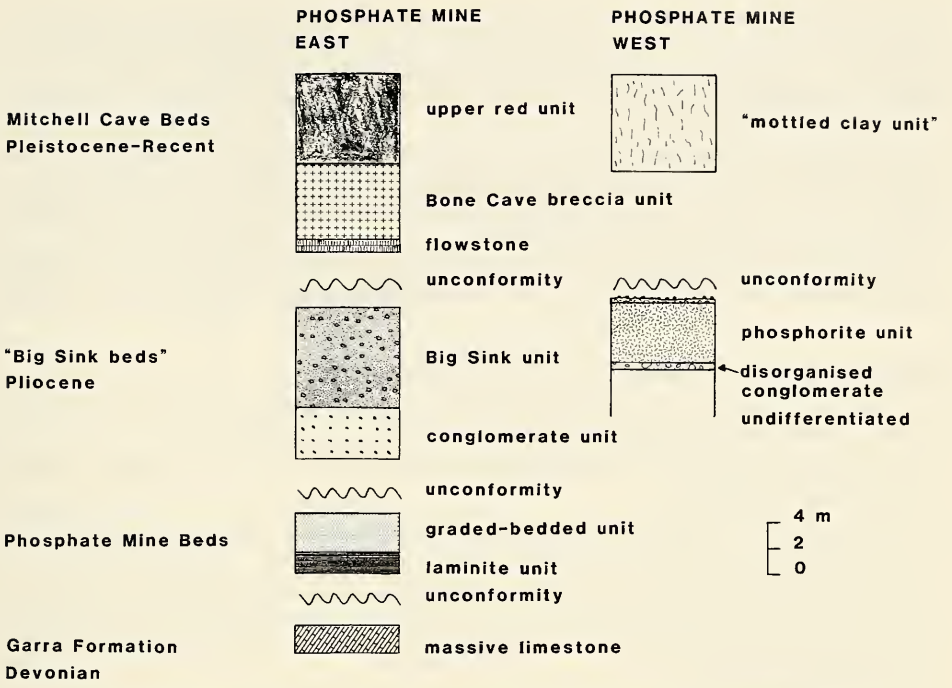

Figure 2. Tentative stratigraphic columns for strata exposed in the Wellington Caves Phosphate Mine.

Rehabilitation and development work on the mine has included removal of fallen mullock from the mine passages, replacement of all unsafe timbering, installation of a new collar on the North Shaft, reopening of the tunnel between the mine and Bone Cave (discovered during the rehabilitation work) and excavation of a new entrance tunnel. The work has also revealed indications that mining commenced in the Big Sink area, that the Grand Canyon began as a shaft and was exhumed as the mining proceeded, that the the mine was electrically lit and that an extensive rail system was used in the mine, probably in conjunction with a hand cart.

Tourist development has involved the laying of paths to disabled access specifications, installation of lighting and services, followed by cleaning of features and passage walls by dry vacuuming.

The removal of mullock from the passages, and of material falling during re-timbering, was carried out so that original mine walls remained undisturbed. Spoil from these operations, which contains significant amounts of out-of-context bone fragments, has been stockpiled in labelled dumps which can be identified with the part of the mine from which they were extracted.

NEW STRATIGRAPHIC OBSERVATIONS

The cleaning and restoration work has revealed whole sequences of strata and significant stratigraphic boundaries which were obscured when Frank (1971) and Osborne (1983) undertook their stratigraphic studies. Opening of the connection between the

mine and Bone Cave, restoration of passages in the Big Sink area and the installation of paths has also meant that it is now much easier to determine level relationships between stratigraphic sections in different parts of the mine. From observations made up till the time of writing (March 1996) it is clear that the stratigraphy of the deposits in the mine is in need of significant revision.

A tentative comparison between the stratigraphic schemes of Frank (1971) and Osborne (1983) and details available from initial examination of the mine after rehabilitation is given in Figure 2. Except where specifically stated, stratigraphic terminology used here follows that of Osborne (1983).

It must be stressed that the work reported here is preliminary and that a detailed reexamination of the mine's stratigraphy will be undertaken later in 1996.

Major points of this new tentative interpretation are :

a) an unconformity between the Big Sink unit, on which flowstone (Unit 2 FS of Frank 1971) is deposited, and the Bone Cave breccia unit.

b) correlation of the Big Sink unit of Osborne (1983) with Unit 1 BG of Frank (1971), as per Osborne (1983).

c) recognition of an unconformity between the Big Sink and conglomerate units (here now grouped as the Big Sink beds) and the graded-bedded unit. Osborne (1983) proposed that the boundary between the conglomerate unit and the graded-bedded unit was likely to be disconformable. Boundaries now revealed in the Bone Cave indicate that the Big Sink unit has an unconformable (in places vertical) boundary with the graded-bedded unit.

It would seem likely that the Big Sink and conglomerate units together form a distinct sequence of strata likely to be of Pliocene age, tentatively named the 'Big Sink beds'.

d) a new stratum, the 'mottled clay unit', which disconformably overlies the phosphorite unit is recognised in the western part of the mine. Fossils collected by H. Godthelp (UNSW, pers. comm.) suggest that this unit is of Pleistocene age.

e) the sequence of strata below the phosphorite unit in the western part of the mine:
- may not be correlated with the graded-bedded and laminate units as was suggested by Osborne (1983)
- has unclear relationships with the Big Sink unit
- contains at least 4m of strata not previously described.

f) the phosphorite unit probably does not conformably overlie the graded-bedded unit as was suggested by Osborne (1983).

g) the Bone Cave breccia unit is far better stratified than has previously been recognised and contains discontinuous thin layers of flowstone.

IMPLICATIONS OF PRELIMINARY OBSERVATIONS

The new stratigraphic observations suggest that the Cainozoic record in the Phosphate Mine contains at least three distinct sequences separated by significant unconformities representing phases of erosion and exhumation of the phosphate mine cave system. The simplest interpretation now possible is shown in Table 1.

The stratigraphic interpretation of Osborne (1983) suggested that the sequence at Wellington Caves had the potential to extend well back into the Tertiary. The emerging new interpretation would lead to a similar conclusion.

Studies of the fauna from the Big Sink unit by Hand et al. (1988) and L. Dawson (UNSW, pers. comm.) have indicated an Early Pliocene age.

The recognition of an unconformity between the graded-bedded unit and the Big Sink and conglomerate units suggests that the older parts of the sequence may be considerably older than Pliocene.

Although bones or bone fragments are found in significant quantities in all of the strata marked with an asterisk, there has yet to be any systematic palaeontological study of the units lower in the sequence than the Big Sink unit.

It is thus highly likely that a detailed revision of the stratigraphy, coupled with palaeontological studies will show that the sequence in the Wellington Caves Phosphate Mine extends well back into the Tertiary.

TABLE 1

A stratigraphic interpretation of sequences at Wellington Caves

Phosphate mine east,	Bone cave and big sink	Phosphate mine west
Mitchell Cave beds	upper red unit *	'mottled clay' unit *#
(Pleistocene-Recent)	Bone Cave breccia unit *#	
	flowstone	
	UNCONFORMITY	UNCONFORMITY
'Big Sink' beds	Big Sink unit *#	phosphorite unit
(Early Pliocene)	conglomerate unit*	disorganised conglomerate
		4m undifferentiated*
	UNCONFORMITY	
Phosphate Mine beds	graded-bedded unit*	
(age unknown)	laminate unit	
	?UNCONFORMITY	?UNCONFORMITY
	phosphate rim rock	phosphate rim rock
	UNCONFORMITY	UNCONFORMITY
Garra Formation (Devonian)	massive limestone	massive limestone

* = bone and bone fragments present

= fossils studied from this unit in Phosphate Mine

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